



The Asian Financial Crisis and international reserve accumulation: A robust control approach

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ABSTRACT

Standard macroeconomic models have difficulties accounting for the surge in international reserves of Asian countries in the aftermath of the Asian Financial Crisis of 1997. We propose precautionary demand for saving generated by model uncertainty as an important driver of this phenomenon. Using Korean data, we estimate a simple permanent income model augmented with model uncertainty, find a structural break at the point of the Asian Financial Crisis, and identify a rise in concern for model misspecification which is distinct from an increase in income volatility. The post-crisis concern for model misspecification implies a reasonable detection error probability. We also show that learning serves as an additional powerful amplification mechanism in our framework.

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1. Introduction

The accumulation of international reserves in many emerging market countries took a dramatic turn in the aftermath of the Asian Financial Crisis of 1997. Fig. 1 plots the simple averages of international reserves to GDP ratios for several groups of countries from 1980 to 2013. From a number slightly above 10% in the mid 90s, international reserves to GDP ratio of the emerging market countries started trending upward following the crisis and nearly doubled by 2009. This pattern is particularly pronounced among Asian countries that were either directly affected by the crisis or close to its epicenter (“AFC + Russia” in the figure¹). The literature has found the quantitative aspect of this surge puzzling as the reserve accumulation in these countries now far exceeds popular measures of reserve adequacy such as 3 to 6 months of imports or full coverage of short-term external debts known as Guidotti–Greenspan rule (Jeanne, 2007). Moreover, standard macroeconomic models have difficulties accounting for this magnitude without resorting to very high levels of risk aversion (Jeanne, 2007; Jeanne and Ranci ere, 2011).

In this paper, we show that model uncertainty helps us understand the international reserve accumulation by Asian countries in the aftermath of the Asian Financial Crisis. Under model uncertainty, economic agents are no longer endowed

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¹ Russia is included in the group due to the close connection between its crisis (which occurred in August of 1998) and the Asian Financial Crisis. The figure is insensitive to the exclusion of China from the group.

Reserves to GDP Ratio (in %)

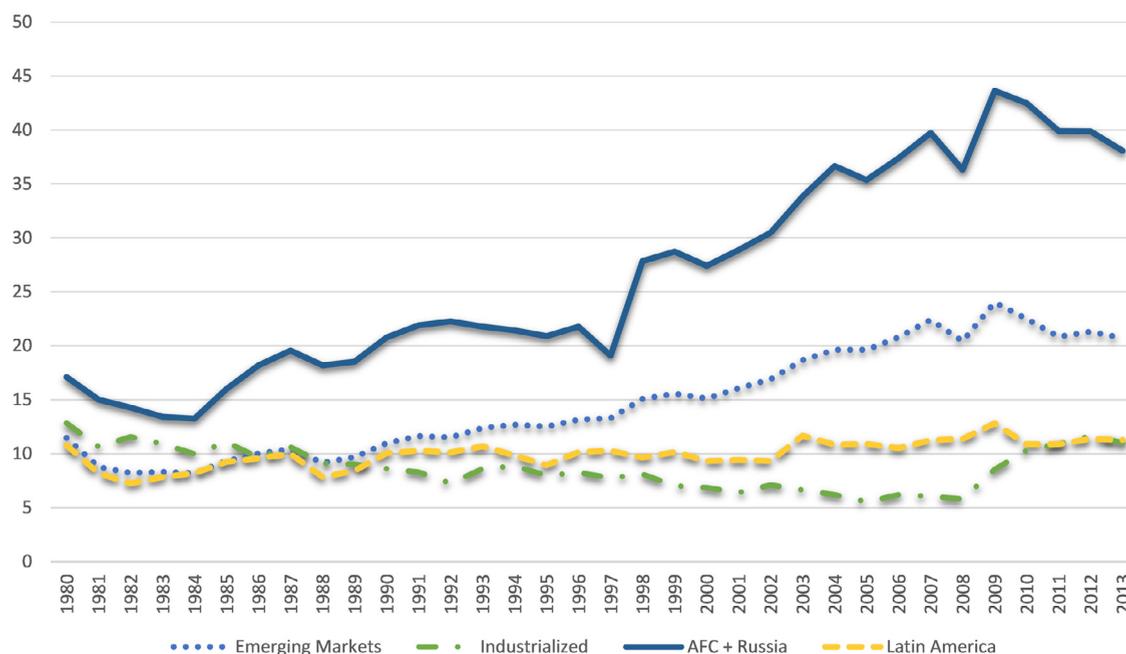


Fig. 1. International reserves to GDP ratio from 1980 to 2013 (in %). Data source: World Bank World Development Indicators. Total international reserves consist of foreign exchange under the control of monetary authorities, monetary gold, special drawing rights, and IMF positions. The figure plots simple averages of countries under the same classification. Emerging Market and Industrialized countries classifications are based on [Jeanne \(2007\)](#). **Emerging Markets:** Argentina, Brazil, Bulgaria, Chile, China, Colombia, Cote d'Ivoire, Dominican Republic, Ecuador, Egypt, El Salvador, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Morocco, Nigeria, Pakistan, Panama, Peru, Philippines, Poland, Russia, Singapore, South Africa, Thailand, Tunisia, Turkey, Ukraine, Uruguay, and Venezuela. **Industrialized:** Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States. **AFC + Russia:** China, Indonesia, Korea, Malaysia, Philippines, Russia (included from 1993 onward), Singapore, and Thailand. **Latin America:** Argentina, Brazil, Chile, Colombia, Dominican Republic, Ecuador, El Salvador, Mexico, Panama, Uruguay, and Venezuela.

with a unique model of the economy. Instead, they entertain a set of possible models and make decisions which reflect this multiplicity. We employ robust control techniques ([Hansen et al., 2010](#); [Hansen and Sargent, 2008a; 2010](#); [Hansen et al., 1999](#)) to model economic agents who cope with model uncertainty by making decisions that serve them best under the worst case scenario.

We follow [Jeanne and Rancière \(2011\)](#) and model international reserves as an instrument of government's social planning problem. The social planner maximizes the representative household's utility by choosing consumption and saving, which is in the form of international reserves, subject to a stochastic income-generating process. Because we focus on the relationship between model uncertainty and the social planner's optimal reserve policy, private sector decisions related to the reserve accumulation are not explicitly modeled in the paper. However, their connection to the model features will be discussed. The interaction between model uncertainty and income volatility will be examined as well.

Our baseline model is a version of [Hansen et al. \(1999\)](#) permanent income model. The use of this model has three justifications. First, the model is well-understood so we can focus on the empirical analysis. Second, the model shares common features with other small open economy models and models of international reserves so our results are highly comparable to theirs. For instance, [Luo et al. \(2012\)](#) use a linear-quadratic permanent income model with robustness to study current account dynamics in a small open economy. Stylized models with exogenous income processes are used extensively in the international reserve accumulation literature ([Bianchi et al., 2016](#); [Jeanne, 2013](#); [Jeanne and Rancière, 2011](#)), and these models have yielded important insights. We follow this tradition. Third, although our model abstracts from institutional features (which vary across different crisis-affected economies), we will argue that our key mechanism is likely to survive in a more elaborate model.

We focus on the Korean crisis episode and the associated reserve accumulation given (a) the prominence of its crisis episode in the literature and (b) the availability and reliability of its macroeconomic and financial data.² We estimate the model using quarterly GDP and international reserves data. Our estimation is performed in three steps. First, we estimate

² We do not attempt to account for reserve accumulation in China, for two reasons. First, China maintained capital controls and a fixed exchange rate during the Asian Financial Crisis, and a major financial crisis did not occur in China. Second, [Jeanne \(2013\)](#) argues that China is a "semi-open" economy: its official sector has access to the international financial markets whereas the private sector does not. The official sector uses reserve accumulation as an

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